MATHEMATICAL MODEL FOR CALCIUM OSCILLATIONS IN NON-EXCITABLE CELLS

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We introduce a general mathematical model to describe calcium oscillations in non-excitable cells. For this purpose, Ca^{2+} oscillations were recorded in single pancreatic acinar cells of the rat. The model takes into account following Ca^{2+} fluxes: V_{IP3}, the flow of Ca^{2+} from the ER into the cytosol via the $InsP_3$-receptor; V_{CRAC}, the capacitive Ca^{2+} entry pathway; V_{SERCA} and V_{PMCA}, sequestration and extrusion of Ca^{2+} and two leak fluxes (from the ER and across the plasma membrane). After choosing realistic parameters, the dynamics of the model were analyzed by bifurcation analysis and compared with experimental data. We show explicitly that the dynamics of Ca^{2+} oscillations generated by the model agrees qualitatively and quantitatively with those observed in real cells. The model is useful to explain hormone-induced Ca^{2+} patterns recorded in pancreatic acinar cells. These patterns are directly involved in the regulation of subcellular processes that control the functionality of the pancreatic acinar cell. Currently, the one-dimensional model is used to build a 2D model to simulate the spatiotemporal kinetics of Ca^{2+} waves. Numerical simulations reveal the presence of hysteresis and bistability in such a 2D model that explains the presence of traveling and spiral Ca^{2+} waves in the system similar to those in real cells.